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ABSTRACT

Based upon the findings of a National Science Foundation (NSF) survey of 1980 Industrial Research and Development, this report presents highlights and summaries of statistical data for: (1) total research and development (R&D) funds for 1980; (2) R&D by source of funds; (3) R&D funds as a percent of net sales; (4) energy-related R&D; and (5) R&D scientists and engineers. (SK)

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SCIENCE RESOURCES STUDIES HIGHLIGHTS

NATIONAL SCIENCE FOUNDATION WASHINGTON, D.C. 20550 DECEMBER 31, 1981 NSF 81-331

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INDUSTRIAL R&D EXPENDITURES IN 1980 SHOW REAL GROWTH FOR FIFTH CONSECUTIVE YEAR

The statistical data presented in this report were collected for the National Science Foundation by the Bureau of the Census in the annual Survey of Industrial Research and Development. Remarks attributed to company officials were based on discussions with several of the leading R&D-performing companies in the major industries.

Highlights

- U.S. industry spent nearly $44 billion on research and development during 1980, an increase of 15 percent over the preceding year. After adjusting for inflation, research and development (R&D) expenditures by industry grew 5 percent, equivalent to the average annual rate experienced between 1975 and 1980.

- Companies' own R&D funds, which reached almost $30 billion in 1980, accounted for most of the real growth in industrial R&D performance between 1979 and 1980. In constant dollars, internally financed research and development grew 7 percent, whereas Federal support of industrial R&D activities showed only a 2-percent increase.

- Of the five major R&D-performing industries, the machinery industry (which includes companies producing office, computing, and accounting machines) reported the highest overall current-dollar increase—18 percent from 1979 to 1980. Firms have been expanding their R&D budgets as they attempt to incorporate increasingly more sophisticated technology into the design of new products to meet the growing demand for computers and related software equipment.

- The motor vehicles industry showed the smallest gain in 1980—9 percent. This industry had previously led the other four major R&D-performing industries by registering the largest average annual increase in R&D spending between 1975 and 1979. This may be a reflection of the 17-percent decline in industry sales between 1978 and 1980.

- Industrial expenditures on energy-related R&D activities rose 15 percent between 1979 and 1980 to over $4 billion. This was the first year since 1972, when energy R&D data were first collected, that these expenditures did not rise at a significantly faster rate than total industrial R&D outlays. This is a result of a deceleration in Federal support of nuclear energy research and development which occurred during this period.

- Industry's employment of full-time-equivalent (FTE) R&D scientists and engineers rose to a new high of 470,000 in January 1981, an increase of 5 percent over the previous year's level. The total number of these professionals grew nearly 30 percent between January 1976 and January 1981, averaging 5.2 percent per year.

Total R&D Funds, 1980

U.S. industry reported total R&D spending of almost $44 billion during 1980—15 percent above the preceding year's level. This represents a 5-percent increase in constant dollars and marks the fifth consecutive year in which total industrial R&D expenditures rose at a faster rate than inflation. The industrial sector, historically the major performer of research and development in the United States, spent approximately 70 percent of total U.S. R&D outlays in 1980.

Between 1975 and 1980 industry's real R&D outlays grew at an average annual rate of 5.1 percent with companies spending approximately 30 percent more on research and development in 1980 than they did five years earlier. This substantial increase, when compared to the 2-percent real decline in total industrial R&D expenditures that occurred during the first half of the decade, reflects an increased willingness on the part of firms to invest their financial resources in research and development. In numerous interviews, corporate officials have emphasized the importance of both product development and process improvement in tackling two major problems affecting the economic welfare of American industry—growing foreign competition and declining domestic productivity.

The NSF data indicate that companies manufacturing products which embody frequently changing, state-of-the-art technology, and for which there is growing demand, e.g., computers and related equipment and software and various types of electrical equipment, are rapidly expanding and intensifying their R&D efforts. Of the five major R&D-performing industries, the machinery industry (which includes firms producing office, computing, and accounting machines) reported the highest current percentage increase—18 percent—in total R&D expenditures between 1979 and 1980. The largest R&D-performing industries—electrical equipment and aircraft and missiles—registered gains of about 16 percent in current dollars. In contrast, the automotive industry, experiencing a slump in sales between 1979 and 1980, had the smallest overall increase in R&D outlays of any major industry in 1980—9 percent. This broke the trend set between 1975 and 1979 when the automotive industry led the other four major R&D-performing industries by registering the largest average annual increase in R&D expenditures during those four years.

R&D by Source of Funds

Companies spent nearly $30 billion of their own funds on research and development during 1980, a 17-percent increase over their 1979 outlays and more than double the amount allocated by the Federal Government in 1980 for industrial R&D activities. The proportion of total industrial research and development which is internally financed has gradually increased to 68 percent from 1959 when it

(Prepared in the Industry Studies Group, Division of Science Resources Studies)

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comprised 41 percent of the total. The diminished role of the Federal Government in industrial research and development during this 21-year period is attributable largely to cutbacks in defense-related R&D activities and curtailment of the U.S. space program which occurred in the late sixties and early seventies (chart 1).

Even with an acceleration of government financing of industrial research and development during the late seventies (including support of R&D activities associated with the space shuttle program and the MX missle and energy-related R&D projects), real growth in Federal funding lagged behind that of firms' own expenditures.

Table 1. Selected data for R&D-performing companies by industry: 1979 to 1980
[Dollars in millions]

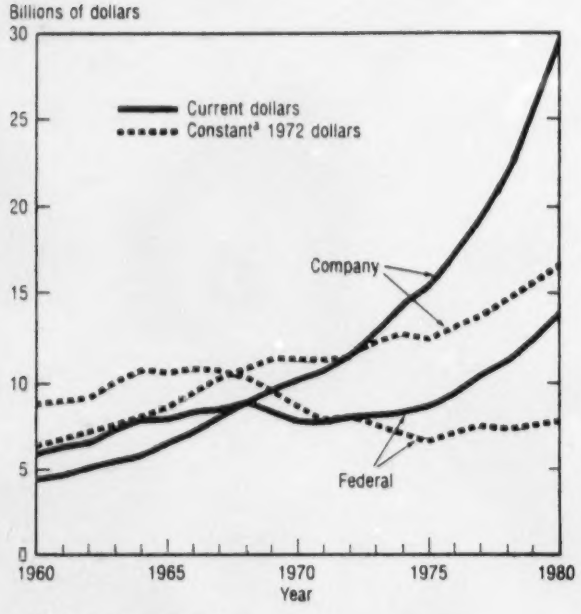
Industry	SIC code	Total R&D Funds		Federal R&D Funds		Company R&D Funds		R&D Scientists/Engineers January	
		1979	1980	1979	1980	1979	1980	1980	1981
Total		$38,200	$43,900	$12,520	$13,950	$25,680	$29,950	447,100	469,900
Food and kindred products	20	460	520	0	0	460	520	7,100	7,500
Textiles and apparel	22,23	90	100	(1)	(1)	(1)	(1)	1,800	1,700
Lumber, wood products, and furniture	24,25	150	170	0	0	150	170	2,220	2,300
Paper and allied products	26	450	510	(1)	(1)	(1)	(1)	7,500	8,200
Chemicals and allied products	28	4,040	4,620	380	410	3,660	4,210	50,100	52,800
Industrial chemicals	281-82,286	2,020	2,280	360	390	1,660	1,890	21,300	22,100
Drugs and medicines	283	1,450	1,670	(1)	(1)	(1)	(1)	20,000	21,100
Other chemicals	284-85,287-89	570	670	(1)	(1)	(1)	(1)	8,800	9,600
Petroleum refining	29	1,280	1,560	160	150	1,120	1,410	11,000	13,400
Rubber products	30	570	650	(1)	(1)	(1)	(1)	(1)	(1)
Stone, clay and glass products	32	350	400	(1)	(1)	(1)	(1)	5,400	(1)
Primary metals	33	610	700	30	40	580	660	8,800	8,200
Ferrous metals and products	331-32,3398-99	290	320	10	10	290	320	4,000	3,600
Nonferrous metals and products	333-36	320	380	30	30	290	350	4,800	4,600
Fabricated metal products	34	480	590	40	50	440	540	8,900	9,300
Machinery	35	5,150	6,090	670	860	4,480	5,230	63,900	65,300
Office, computing, and accounting machines	357	3,610	4,290	620	790	2,990	3,490	43,600	46,100
Electrical equipment	36	7,920	9,120	3,410	3,730	4,510	5,390	97,400	105,800
Radio and TV receiving equipment	365	60	80	0	0	60	80	800	1,000
Electronic components	367	1,050	1,350	(1)	(1)	(1)	(1)	18,200	(1)
Communication equipment	366	3,950	4,500	1,700	1,800	2,250	2,700	47,100	51,200
Other electrical equipment	361-64,369	2,860	3,190	(1)	(1)	(1)	(1)	31,300	33,700
Motor vehicles and motor vehicles equipment	371	4,450	4,840	700	600	3,740	4,240	34,400	30,400
Other transportation equipment	373-75,379	150	150	80	80	70	80	1,300	1,200
Aircraft and missiles	372,376	8,290	9,630	6,000	6,900	2,290	2,730	87,100	96,100
Professional and scientific instruments	38	2,050	2,260	220	130	1,830	2,130	27,300	27,000
Scientific and mechanical measuring instruments	381-82	600	740	40	40	570	690	(1)	11,000
Optical, surgical, photographic, and other instruments	383-87	1,450	1,530	190	90	1,270	1,440	16,300	16,300
Other manufacturing industries	21,27,31,39	320	410	10	50	310	360	4,700	5,000
Nonmanufacturing industries	07-17,41-67, 737, 739,807, 891	1,390	1,580	680	780	710	800	19,200	20,900

[1] Not separately available but included in total.

Source: National Science Foundation

Note: Data may not add to totals because of rounding to nearest ten million dollars.

Chart 1. Industrial R&D expenditures by source of funds: 1960-80



[a]Based on GNP implicit price deflator
SOURCE: National Science Foundation

rising at an average annual rate of only 2.8 percent as compared with company outlays which averaged 6.3 percent between 1975 and 1980.

Of the approximately $4 billion in additional company funds invested in research and development during 1980, nearly 40 percent was spent by the electrical equipment and machinery industries. These two industries are the largest performers of privately financed research and development (accounting for over one-third of the total amount of company funds spent in 1980). The electrical equipment industry also reported the largest percentage increase in company R&D outlays between 1979 and 1980—20 percent—of any of the major R&D-performing industries. Data from companies in the aircraft and missiles industry indicate that these firms intensified their own investment in research and development between 1978 and 1980. Although company funds remained a relatively small portion of this industry's total R&D effort in 1980 (28 percent), the total company R&D budget of this industry in that year was almost twice that of 1978. These extra funds were used primarily to finance the development of large commercial aircraft.

Federally financed industrial research and development increased 11 percent (2 percent in constant dollars) from $12.5 billion in 1979 to $14 billion in 1980. Federal support of R&D projects undertaken by the aircraft and missiles industry increased 15 percent. This industry received half of all Federal monies for industrial research and development in 1980. Two industries reported dramatic changes in Federal R&D support. The machinery industry showed a sizable gain, 28 percent in current dollars, and the automotive industry exhibited a 14-percent decline. Federal funds, however, account for less than 15 percent of the total R&D efforts of each of these two industries.

R&D Funds as a Percent of Net Sales

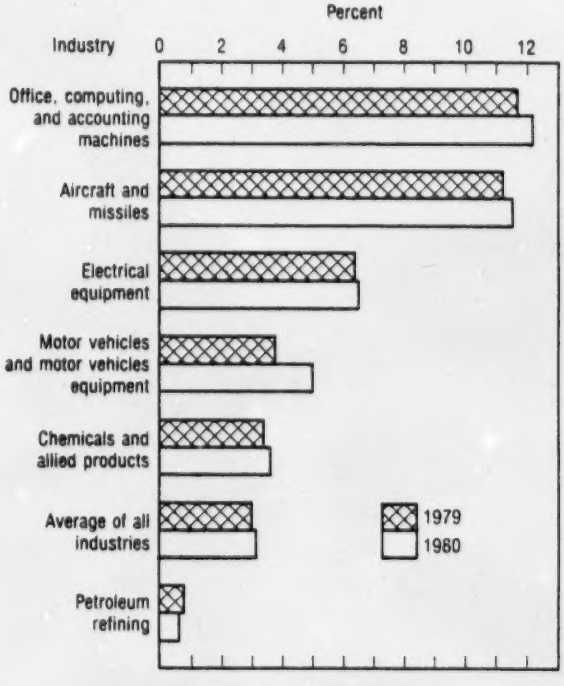
The ratio of total industrial R&D expenditures to net sales rose slightly between 1979 and 1980 from 3.0 percent to 3.1 percent. After reaching a peak of 4.6 percent in 1964, this ratio fell for a 10-year period, then stabilized in 1974 around this 3.1-percent level.

An examination of R&D/net sales ratios for individual industries reveals that all but three industries reported higher percentages in 1980 than in the previous year. The five major R&D-performing industries all showed larger percentage increases in R&D expenditures than in net sales generated during 1980. One of the industries that did not show an increase was the petroleum industry which historically has had the greatest dollar volume of sales of any industry. The 1979-80 growth in sales by the petroleum industry was a significant factor in limiting the increase in the all-industry R&D/net sales ratio to one-tenth of 1 percent.

The ratio of R&D/net sales for the machinery industry jumped from 5.0 percent to 5.6 percent between 1979 and 1980. Firms which manufacture office, computing, and accounting machines account for over two-thirds of the R&D funds expended by this industry and were largely responsible for this increase. The R&D/net sales ratio for this group of companies rose from 11.7 percent in 1979 to 12.2 percent in 1980 (chart 2).

The R&D/sales ratio of the motor vehicles industry rose dramatically from 3.8 percent to 5 percent during 1980, largely because of a downturn in sales during the period.

Chart 2. R&D funds as a percent of net sales for selected industries: 1979 and 1980



SOURCE: National Science Foundation

Energy Research and Development

Expenditures for energy-related research and development showed a threefold increase in real terms between 1972 (the year this time series began) and 1980. The magnitude of this increase illustrates an important national priority—enlarging this country's investment in energy research and development to improve the efficiency of existing fuels and to discover alternative sources of supply.

Funding of energy R&D projects grew at a faster pace than total R&D expenditures each year between 1972 and 1979. In 1980, however, this rate of growth leveled off—expenditures for energy R&D activities showed a 15-percent increase, the same as the overall total

industrial R&D increase in 1980. A further indication that the upsurge in energy R&D expenditures may have ended is that companies project only a 9-percent increase for 1981.

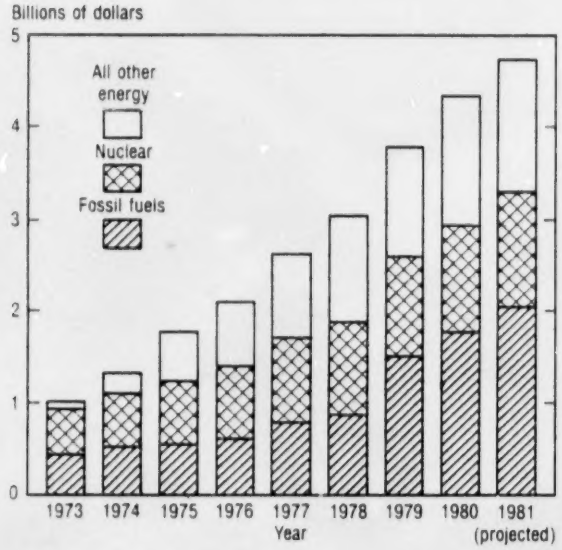
The electrical equipment and petroleum industries spent the largest sums on energy research and development, $1 billion and $862 million, respectively, in 1980. Although these industries reported the first and second largest absolute gains in 1980, they represented the smallest percentage increases, 14 percent and 11 percent, respectively, of any major industry. Oil companies, however, projected a 27-percent increase for 1981, whereas firms in the electrical equipment industry expect to spend only 8 percent more on energy-related R&D activities. The slowdown in Federal support (primarily from the Department of Energy) of the energy research and development performed by the electrical equipment industry was responsible for this small increase.

Only 2 percent of the machinery industry's total R&D expenditures are devoted to energy research and development. This industry, however, exhibited a 24-percent gain in these funds during 1980, reflecting in part the growing application of computer technology in the development of energy-monitoring devices.

About 40 percent of energy research and development is concentrated on fossil fuels, including oil, gas, and coal. Although total expenditures on these sources rose 17 percent, the Federal portion declined 12 percent during 1980. Companies estimate that outlays for fossil fuels research and development will increase 15 percent in 1981 (chart 3).

Almost all nuclear energy research and development—87 percent—is financed by the Government. These activities showed a 16-percent increase in Federal support in 1980, but total nuclear-related R&D funds were projected to increase only 4 percent during 1981.

Chart 3. Industrial expenditures for energy research and development: 1973-81 (projected)



SOURCE: National Science Foundation

R&D Scientists and Engineers

Historically, the annual percentage increase in the total number of FTE R&D scientists and engineers employed by industry has paralleled the annual constant-dollar gain in total industry R&D expenditures. Between January 1980 and January 1981, the number of these individuals working in industry rose 5 percent—equaling the real percentage increase in R&D funds—to a record level of 468,000. This was the fifth year in succession that R&D professional employment grew by at least 5 percent, averaging 5.2 percent between January 1976 and January 1981 (again paralleling the overall average annual increase in total real spending by industry).

The electrical equipment and aircraft and missiles industries employed over two-fifths of the total number of scientists and engineers working for industry in January 1981, 106,000 and 96,000, respectively. Of the five leading R&D-performing industries, these two registered the largest year-to-year percentage increases—9 percent and 10 percent—which together amounted to approximately 75 percent of the additional R&D scientists and engineers hired by all companies during 1980. If this trend continues in the aircraft and missiles industry, its R&D professional work force may soon surpass 100,000, the level of employment maintained in the late sixties when the Federal Government was heavily financing military hardware development and space exploration.

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